Chapter 2
Hardware Component Overview

This chapter provides an overview of the routing node's hardware components:

Routing Node Chassis

The routing node chassis is a rigid sheet metal structure that houses all the other routing node components (see Figure 1 and Figure 2). The chassis measures 37.45 in. (95.6 cm) high, 17.43 in. (44.3 cm) wide, and 31 in. (78.7 cm) deep. The chassis installs into standard 19-in. equipment racks or telco center-mount racks. Up to two routing nodes can be installed into one standard (44-U) rack, assuming it can handle their combined weight (which can be greater than 1100 lb).

The chassis includes the following features (see Figure 1 and Figure 2):

- Two pairs of metal ears, one for center-mounting. and one for mounting in a front-mount or four-post rack or a cabinet.

- Upper and lower handles on each side to facilitate positioning the routing node in the rack. Do not use the handles to lift the routing node.

- Two electrostatic discharge points (banana plug receptacles), one front and one rear.

Caution

Before removing or installing any components of a functioning routing node, attach an ESD strap to one of the two ESD points on the chassis and attach the other end of the strap around your bare wrist. Failure to use an ESD strap could result in damage to the routing node and its components.

Figure 1: Front View of Routing Node Chassis

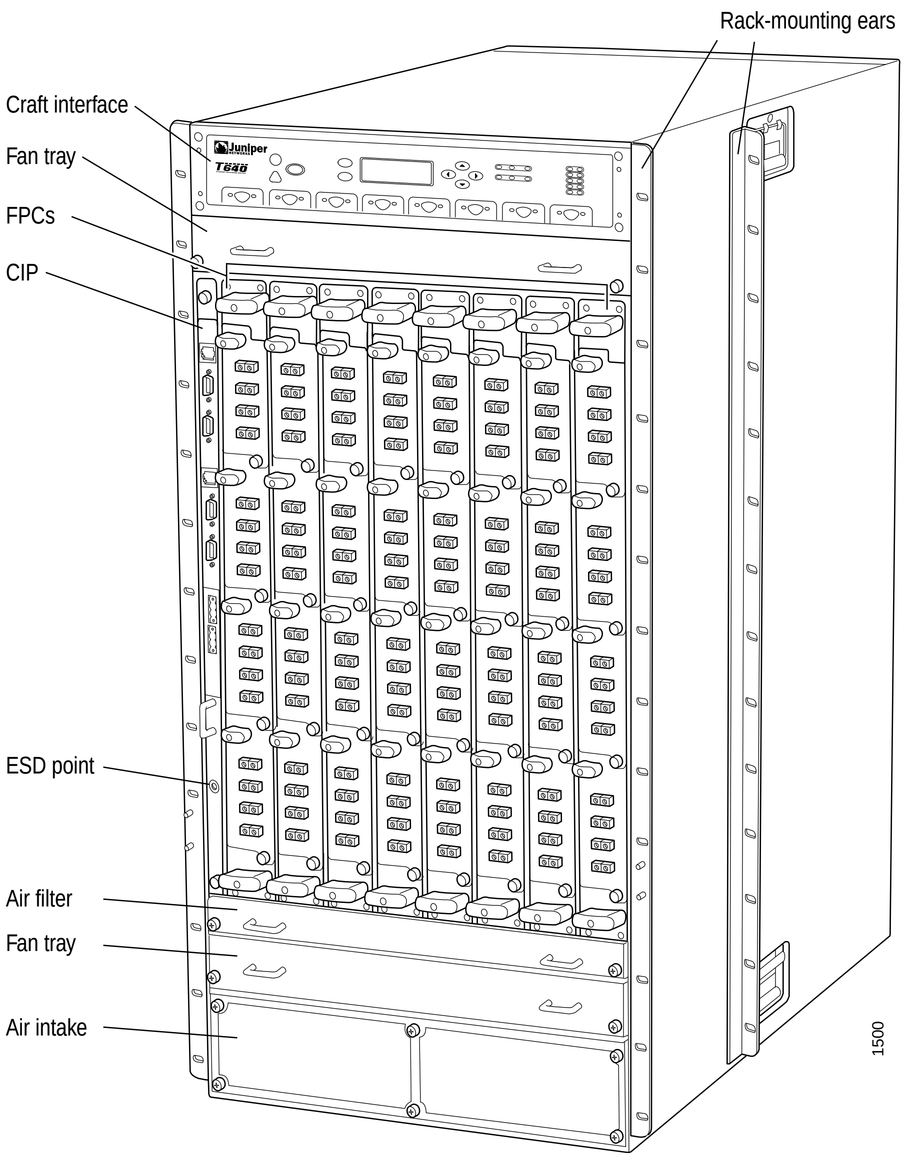
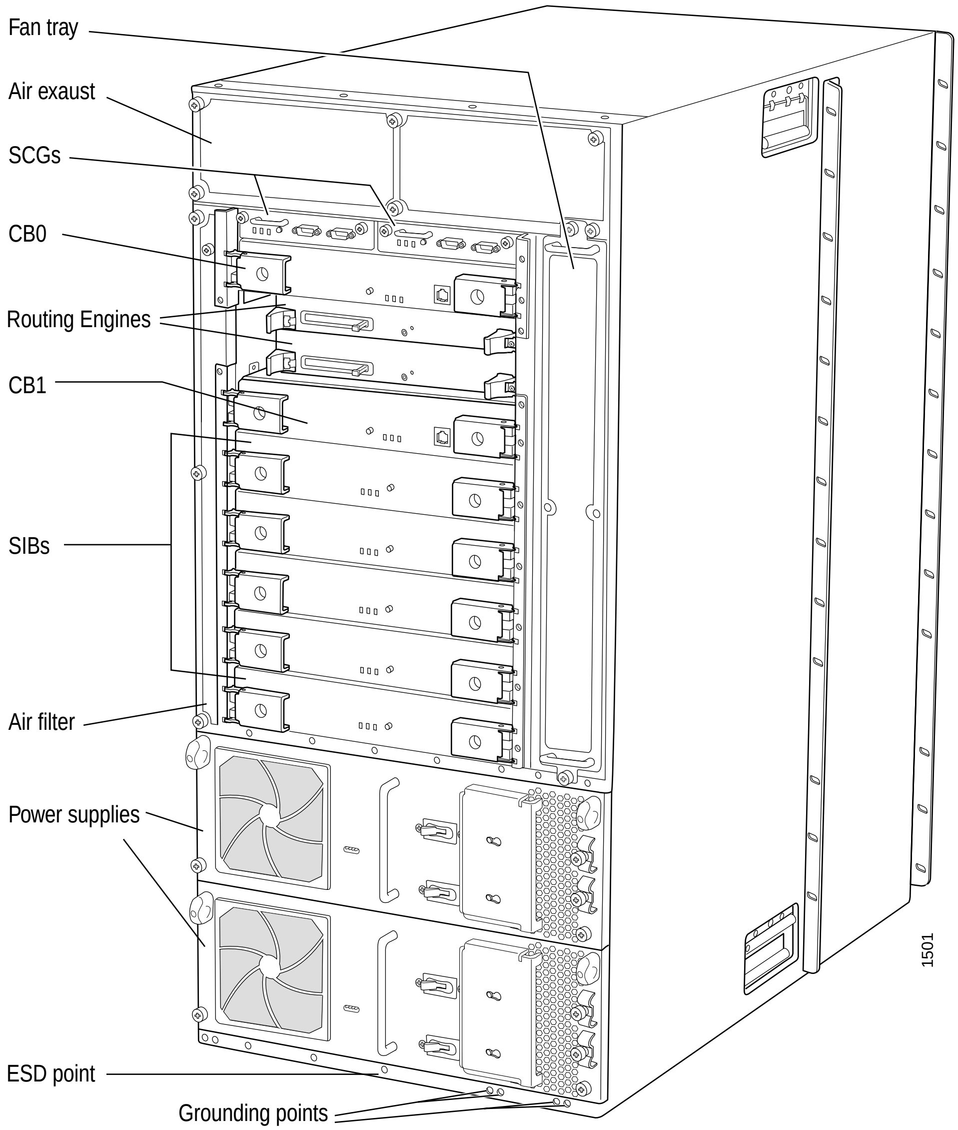


Figure 2: Rear View of Routing Node Chassis



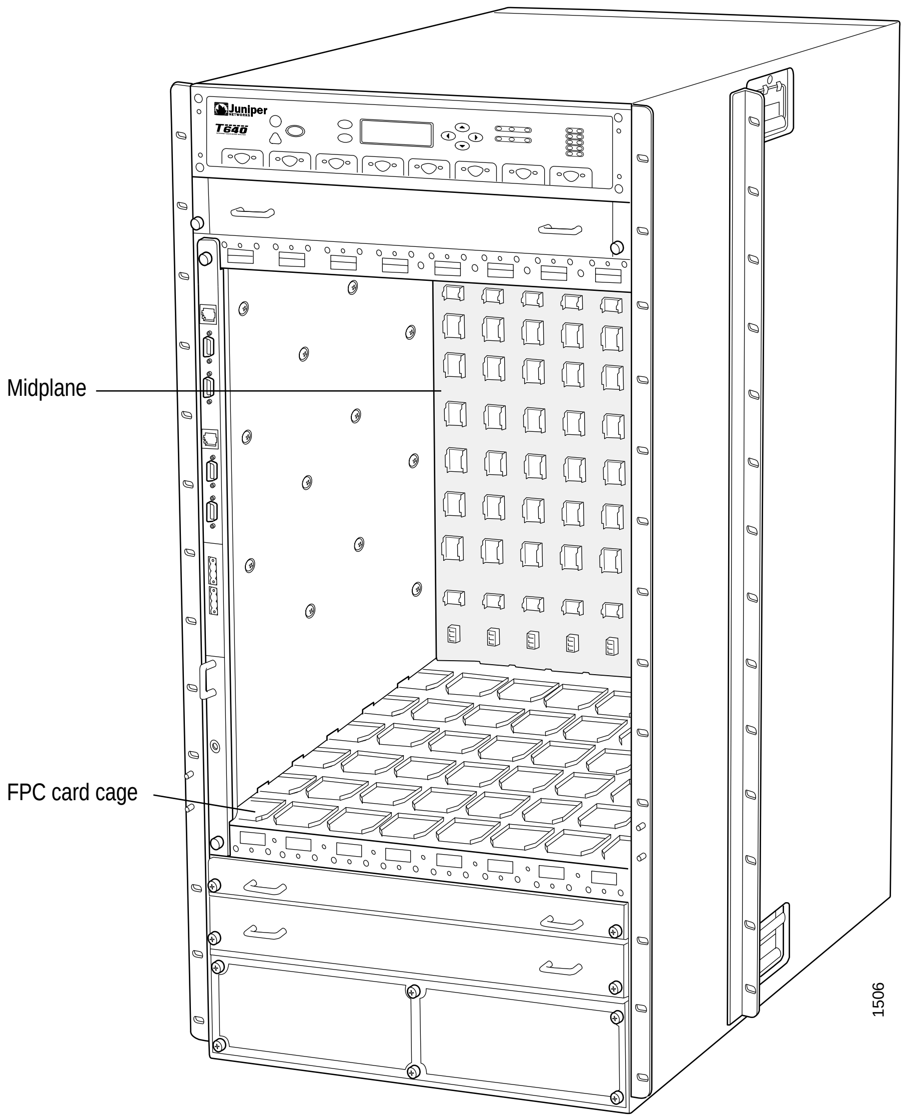
Midplane

The midplane is located in the center of the chassis and forms the rear of the FPC card cage (see Figure 3). The FPCs install into the midplane from the front of the chassis, and the SIBs, Routing Engines, CBs, and SCGs install into the midplane from the rear of the chassis. The power supplies and cooling system components also connect to the midplane.

The midplane performs the following major functions:

- Data transfer—Data packets are transferred across the midplane from the Packet Forwarding Engine on the originating FPC to the SIBs, and from the SIBs across the midplane to the Packet Forwarding Engine on the destination FPC.
- Power distribution—The routing node power supplies are connected to the midplane, which distributes power to all the routing node components.
- Signal connectivity—The midplane provides signal connectivity to the FPCs, SIBs, Routing Engines, CB, and other system components for monitoring and control of the system.

Figure 3: Midplane



Flexible PIC Concentrators (FPCs)

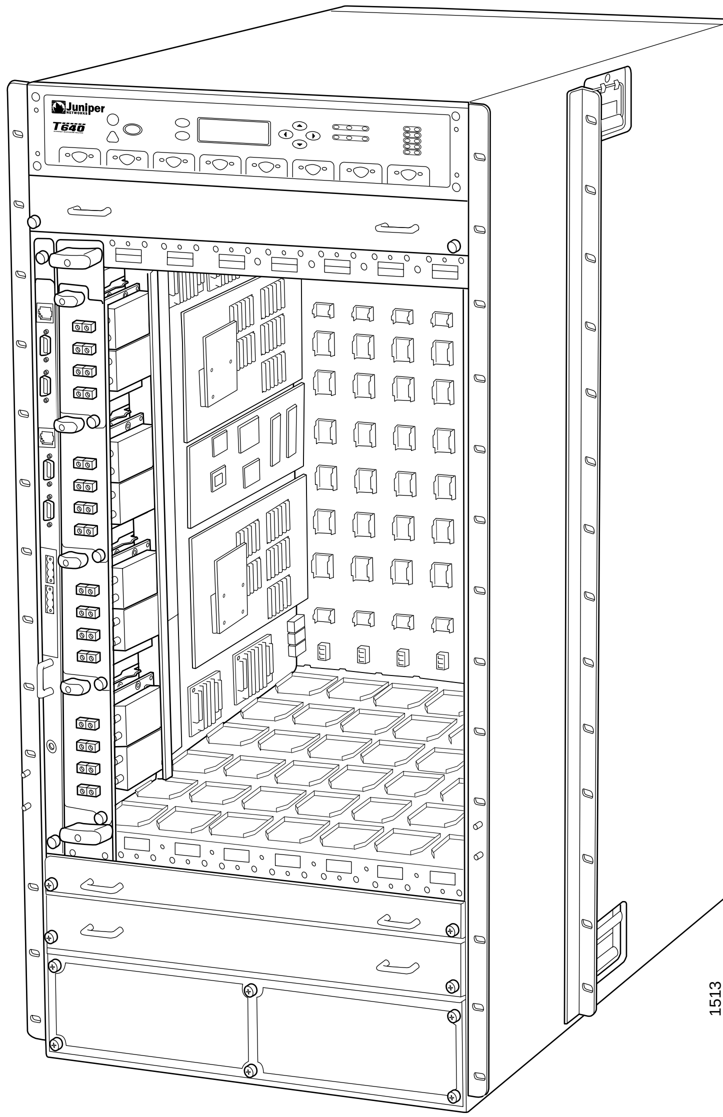
Up to eight Flexible PIC Concentrators (FPCs) install vertically in the front of the routing node (see Figure 4). The FPCs are numbered left to right from FPC0 to FPC7. Each FPC has four connectors into which a PIC can be installed, allowing up to four PICs per FPC. An FPC can be installed into any FPC slot on the routing node, regardless of which PICs it contains.

If a slot is not occupied by an FPC, an FPC blank panel must be installed to shield the empty slot and to allow cooling air to circulate properly through the routing node.

Each FPC contains one or two Packet Forwarding Engines. The Packet Forwarding Engines receive incoming packets from the PICs installed on the FPC and forward them through the switch planes to the appropriate destination port. Each FPC contains data memory which is managed by the Queuing and Memory Interface ASICs.

FPCs are hot-removable and hot-insertable. When you bring an FPC online, the Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs in the FPC are enabled. No interruption occurs to the routing functions.

Figure 4: FPC Installed in Routing Node Chassis



FPC2 and FPC3

The routing node supports two types of FPC (see Figure 5):

FPC2—Rated at 10 Gbps full duplex, supports PICs also used in the M160 router.

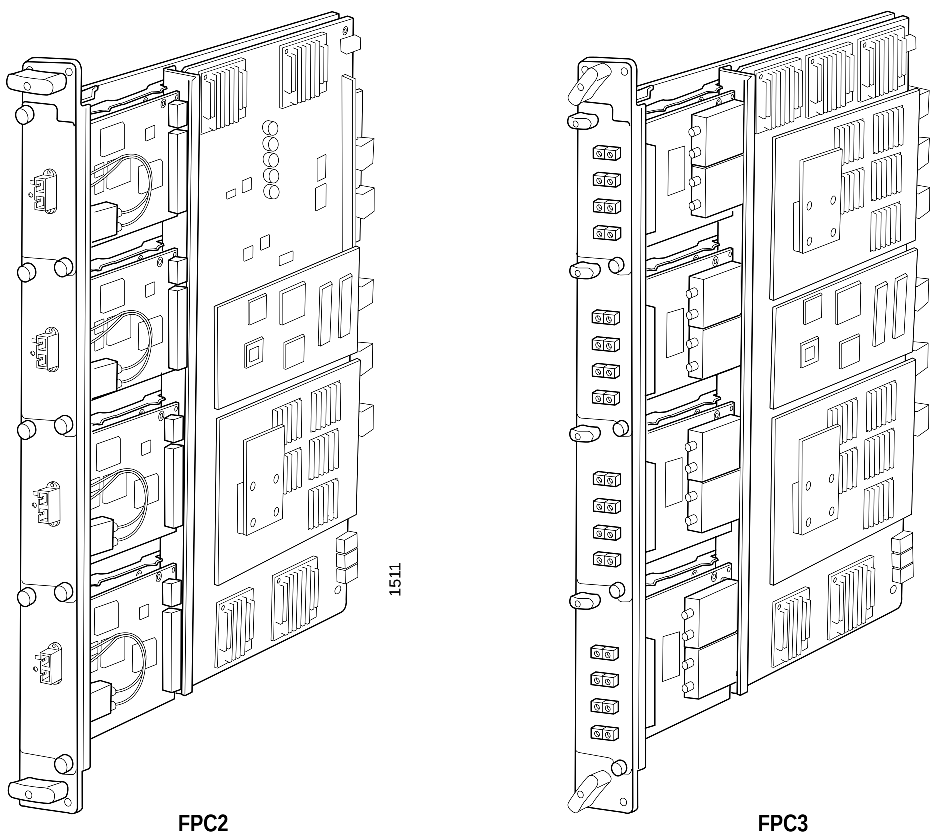
FPC3—Rated at 40 Gbps full duplex, supports higher-speed PICs.

The routing node can operate with any combination of FPC2s and FPC3s installed.

The installation and removal of the two FPC types is identical. You can visually distinguish the two types of FPC by the different ejectors on the PICs installed in the FPC. PICs compatible with an FPC3 have a plastic ejector handle at the top of their faceplate, and PICs compatible with an FPC2 have captive screws at the top and bottom of their faceplate.

In this manual, both types are referred to simply as “FPC” except where the differences between the two are discussed.

Figure 5: FPC2 and FPC3



FPC Components

Each FPC consists of the following components:

- FPC card carrier.
- One or two Packet Forwarding Engines, consisting of Layer 2/Layer 3 Packet Processing ASICs, Switch Interface ASICs, T-Series Internet Processor ASICs, and a memory subsystem (MMB) which includes the Queuing and Memory Interface ASICs. Each FPC3 has two Packet Forwarding Engines, and each FPC2 has one Packet Forwarding Engine.
- Processor subsystem (PMB), which includes a 300-MHz CPU, system controller, 256 MB of SDRAM, and two Fast Ethernet interfaces.
- Two LEDs, located on the craft interface above the FPC, that display the status of the FPC. For more information on the FPC LEDs, see “FPC LEDs” on page 25.
- FPC online/offline button, located on the craft interface above the FPC.

Physical Interface Cards (PICs)

Physical Interface Cards (PICs) provide the physical connection to various network media types, receiving incoming packets from the network and transmitting outgoing packets to the network. During this process, each PIC performs framing and line-speed signaling for its media type. Before transmitting outgoing data packets, the PICs encapsulate the packets received from the FPCs. Each PIC is equipped with an ASIC that performs control functions specific to the media type of that PIC.

PICs are hot-removable and hot-insertable. You can install up to four PICs into the slots in each FPC. PICs used in an FPC2 have captive screws at their upper and lower corners, and PICs used in an FPC3 have an upper ejector handle and a lower captive screw.

PIC Media Types

PICs for the T640 Internet routing node currently support the following network media types:

- Gigabit Ethernet
- SONET/SDH OC-12c/STM-4, OC-48c/STM-16, and OC-192c/STM-64
- Tunnel services

For more information on PICs used in the routing node, see the *T640 Internet Routing Node PIC Guide*.

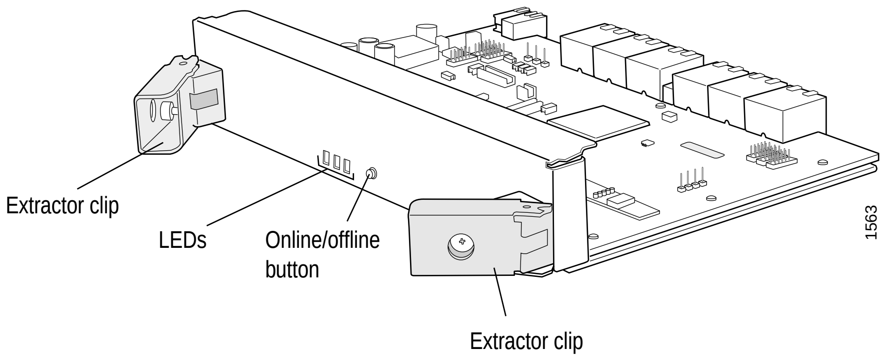
Switch Interface Boards (SIBs)

The Switch Interface Boards (SIBs) provide the switching function to the destination FPC (see Figure 6). The SIBs create the switch fabric for the routing node, providing up to a total of 640 million packets per second (Mpps) of forwarding.

Five SIBs are installed in the routing node. The SIBs are located at the center rear of the chassis in the slots labeled SIB0 through SIB4.

SIBs are hot-insertable and hot-removable.

Figure 6: SIB



SIB Components

Each SIB consists of the following components:

- Switch Fabric ASICs.
- High-speed links (HSLs) to each FPC.
- Three LEDs, located on the SIB faceplate and replicated on the craft interface, that display the status of the SIB. Table 3 describes the functions of the SIB LEDs.
- SIB online/offline button, located on the SIB faceplate.

Table 3: SIB LEDs

Label	Color	State	Description
OK	Green	On steadily	SIB is functioning normally.
		Blinking	SIB is starting up.
FAIL	Amber	On steadily	SIB has failed.
ACTIVE	Green	On steadily	SIB is in active mode.

Host Subsystem

The host subsystem provides the routing and system management functions of the routing node. The host subsystem consists of the following components:

- Routing Engine
- Control Board (CB)

You can install one or two host subsystems on the routing node. Each host subsystem functions as a unit; the Routing Engine requires the corresponding CB to operate, and vice-versa. If the adjacent component is not present, the Routing Engine or CB will not function.

Each host subsystem has three LEDs that display its status. The host subsystem LEDs are located on the right side of the craft interface. For more information about the host subsystem LEDs, see “Host Subsystem LEDs” on page 25.

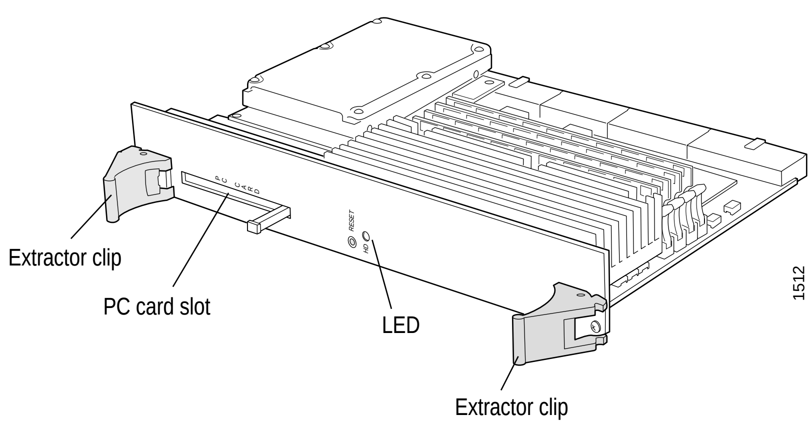
Routing Engine

The Routing Engine maintains the routing tables used by the routing node and controls the routing protocols that run on the routing node. Each Routing Engine consists of an Intel platform running JUNOS Internet software (see Figure 7). For a more detailed description of the Routing Engine, see “System Architecture Overview” on page 41.

You can install one or two Routing Engines in the routing node. The Routing Engines install into the upper rear of the chassis in the slots labeled RE0 and RE1. If two Routing Engines are installed, one functions as master and the other acts as backup. If the master Routing Engine fails or is removed, the backup restarts and becomes master.

The Routing Engines are hot-pluggable. Each Routing Engine requires a CB to be installed in the adjacent slot. RE0 installs below CB0, and RE1 installs above CB1. A Routing Engine does not function if no CB is present in the adjacent slot.

Figure 7: Routing Engine



Routing Engine Components

Each Routing Engine (shown in Figure 7) is a two-board system with the following components:

CPU—Runs JUNOS Internet software to maintain the routing node's routing tables and routing protocols. It has a Pentium-class processor.

SDRAM—Provides storage for the routing and forwarding tables and for other Routing Engine processes.

Compact flash disk—Provides primary storage. It can accommodate two software images, two configuration files, and microcode. This disk is fixed and inaccessible from outside the routing node.

Hard disk—Provides secondary storage for log files, memory dumps, and rebooting the system if the flash disk fails.

PC card slot—Accepts a removable PC card, which stores software images for system upgrades.

Interfaces for out-of-band management access—Provide information about Routing Engine status to devices (console, laptop, or terminal server) that can be attached to access ports located on the CIP. For more information, see "Connector Interface Panel (CIP)" on page 26.

EEPROM—Stores the serial number of the Routing Engine.

LED—Indicates disk activity for the internal IDE interface. It does not necessarily indicate routing-related activity.

The LEDs that report Routing Engine status are located on the craft interface, rather than on the Routing Engine faceplate. For more information, see "Routing Engine Ports" on page 27.

Reset button—Reboots the Routing Engine when pressed.

Extractor clips—Control the locking system that secures the Routing Engine in the chassis.

Note

For specific information about components in your Routing Engine (for example, the capacity of the hard disk), issue the `show chassis routing-engine` command.

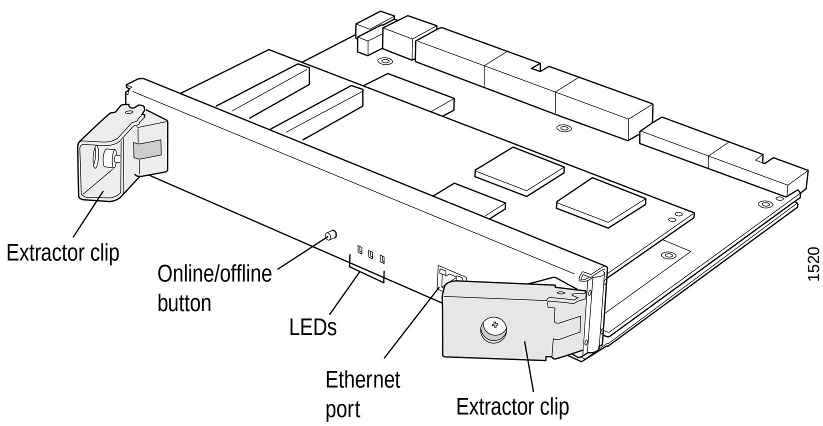
Control Board (CB)

Each Control Board (CB) works with an adjacent Routing Engine to provide control and monitoring functions for the routing node (see Figure 8). These include determining Routing Engine mastership, controlling power, reset and SONET clocking for the other routing node components, monitoring and controlling fan speed, and monitoring system status using I^2C controllers.

You can install one or two CBs in the routing node. The CBs install into the upper rear of the chassis in the slots labeled CBO and CB1. If two CBs are installed, one functions as master and the other acts as backup. If the master CB fails or is removed, the backup restarts and becomes master.

The CBs are hot-pluggable. Each CB requires a Routing Engine to be installed in the adjacent slot. CB0 installs above RE0, and CB1 installs below RE1. A CB does not function if no Routing Engine is present in the adjacent slot.

Figure 8: CB



CB Components

Each CB consists of the following components:

- 100-MB Ethernet switch for intermodule communication.
- PCI bus to the Routing Engines.
- Processor subsystem (SPMB).

Three LEDs, located on the CB faceplate, indicate the status of the CB. Table 4 describes the functions of the CB LEDs.

CB online/offline button, located on the CB faceplate.

> **Note**
> The online/offline button on the CB is currently non-functional.

Table 4: CB LEDs

Label	Color	State	Description
OK	Green	On steadily	CB is online and is functioning normally.
FAIL	Amber	On steadily	CB has failed.
MASTER	Blue	On steadily	CB is functioning as master.

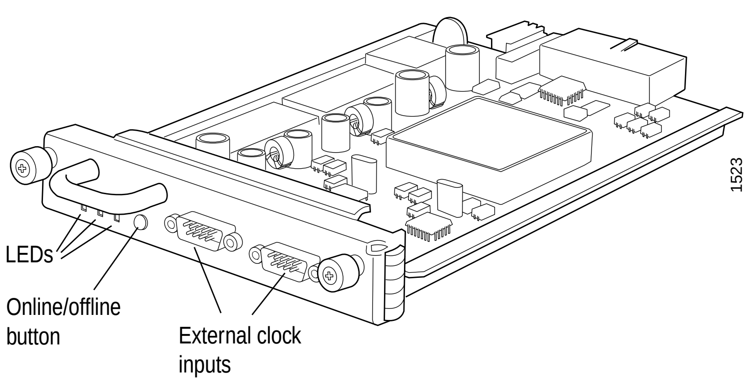
SONET Clock Generators (SCGs)

The SONET Clock Generators (SCGs) provide 19.44-MHz Stratum 3 clock signal for the SONET/SDH interfaces on the routing node (see Figure 9). The SCGs can also select a clock signal from any FPC, or from the external clock inputs.

The SCGs install into the upper rear of the chassis in the slots labeled SCG0 and SCG1.

The SCGs are hot-pluggable.

Figure 9: SCG



SCG Components

Each SCG consists of the following components:

- 19.44-MHz Stratum 3 clock.
- Two external clock inputs, labeled EXT CLK INPUT A and EXT CLK INPUT B.
- FPGA that monitors external clock inputs and performs multiplexing of clock sources.
- Three LEDs, located on the SCG faceplate, that display the status of the SCG. Table 5 describes the functions of the SCG LEDs.
- SCG online/offline button, located on the SCG faceplate.

Table 5: SCG LEDs

Label	Color	State	Description
OK	Green	On steadily	SCG is online and is functioning normally.
FAIL	Amber	On steadily	SCG has failed.
MASTER	Blue	On steadily	SCG is functioning as master.

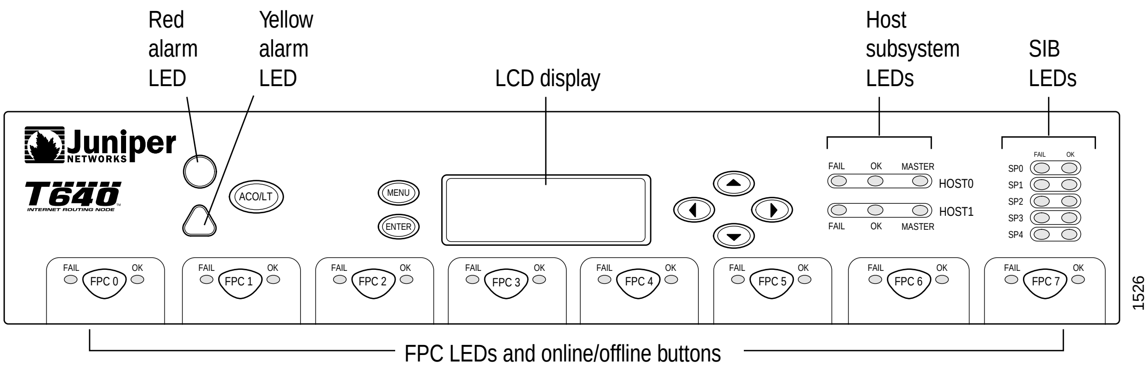
Craft Interface

The craft interface allows you to view status and troubleshooting information at a glance and to perform many system control functions. The craft interface is located on the front of the routing node above the FPCs and contains the following:

- Alarm LEDs and Lamp Test Button on page 23
- LCD Display and Navigation Buttons on page 23
- Host Subsystem LEDs on page 25
- SIB LEDs on page 25
- FPC LEDs on page 25
- FPC Online/Offline Buttons on page 25

The craft interface is hot-insertable and hot-removable.

Figure 10: Front Panel of the Craft Interface



Alarm LEDs and Lamp Test Button

One large, circular red alarm LED and one large, triangular yellow alarm LED are located on the upper left of the craft interface. The red alarm indicates a critical condition that can result in a system shutdown. The yellow alarm indicates a less severe condition that requires monitoring or maintenance. Both alarms can occur simultaneously.

You deactivate red and yellow alarms by pressing the alarm cutoff button (labeled ACO/LT) located next to the alarm LEDs. Deactivating an alarm only silences the devices; it does not remove the alarm message from the LCD display. You can remove the message from the display only by clearing the conditions causing the alarm.

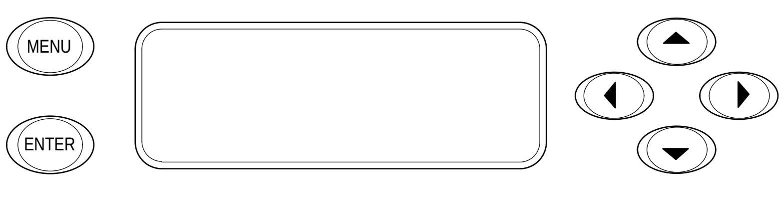
LCD Display and Navigation Buttons

The craft interface has a four-line LCD display with six navigational buttons. The display operates in one of two modes:

Idle mode—The default mode that displays system status.

Alarm mode—Displays alarm conditions when a red or yellow alarm LED is lit.

Figure 11: LCD Display



Idle Mode

Idle mode is the default mode of the LCD display. In idle mode, the screen displays the current system status (see Figure 12):

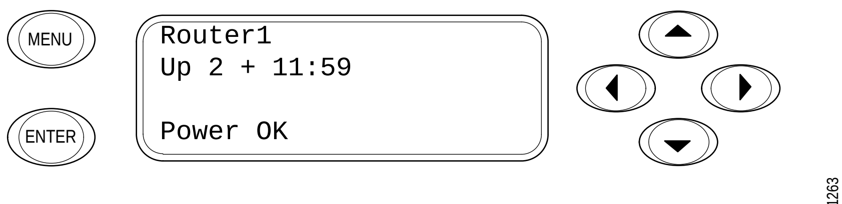
First line—Name of the routing node.

Second line—Number of days, hours, minutes, and seconds that the routing node has been running since last booted.

Third and fourth lines—Status messages, which rotate at 2-second intervals. These messages can be temporarily interrupted during special situations involving hot removal and hot insertion of routing node components.

You can override the normal idle mode display with a system message by typing the message from the command-line interface (CLI). An override message alternates every 2 seconds with the status messages for the period of time you specify.

Figure 12: Idle Mode



Alarm Mode

When a red or yellow alarm occurs, alarm mode preempts idle mode and displays a message to alert you of serious alarm conditions. In alarm mode, the screen displays the following information (see Figure 13):

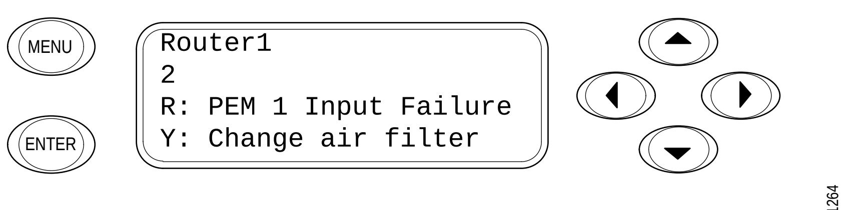
First line—Name of the routing node.

Second line—Number of alarms active on the routing node.

Third and fourth lines—Individual alarms, with the most severe condition shown first. Each line indicates whether the alarm is a red (R) or yellow (Y) alarm.

For a list of alarm mode message types, see “Display Alarm Messages” on page 219.

Figure 13: Alarm Mode



Host Subsystem LEDs

Each host subsystem has three LEDs, located on the upper right of the craft interface, which indicate its status. The LEDs labeled HOST0 show the status of the Routing Engine in slot RE0 and the CB in slot CB0. The LEDs labeled HOST1 show the status of the Routing Engine in slot RE1 and the CB in slot CB1. Table 6 describes the functions of the host subsystem LEDs.

Table 6: Host Subsystem LEDs

Label	Color	State	Description
OK	Green	On steadily	Host is online and is functioning normally.
FAIL	Red	On steadily	Host is offline.
MASTER	Green	On steadily	Host is functioning as master.

SIB LEDs

Each SIB has two LEDs on the craft interface which indicate its status. The SIB LEDs, labeled SIB0 through SIB4, are located at the upper right of the craft interface. The ACTIVE LED is not replicated on the craft interface. Table 7 describes the functions of the SIB LEDs.

Table 7: SIB LEDs

Label	Color	State	Description
OK	Green	On steadily	SIB is functioning normally.
FAIL	Red	On steadily	SIB has failed.

FPC LEDs

Each FPC slot has two LEDs which indicate its status. The FPC LEDs, labeled FPC0 through FPC7, are located along the bottom of the craft interface. Table 8 describes the functions of the FPC LEDs.

Table 8: FPC LEDs

Label	Color	State	Description
OK	Green	On steadily	FPC is functioning normally.
		Blinking	FPC is starting up.
FAIL	Red	On steadily	FPC has failed.

FPC Online/Offline Buttons

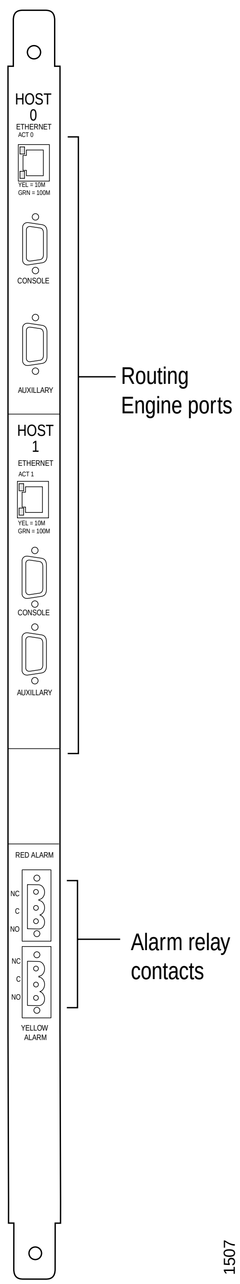
Each FPC also has a button that you use to take the FPC offline and bring it online. The button is located next to the FPC LEDs on the bottom of the craft interface.

Connector Interface Panel (CIP)

The Connector Interface Panel (CIP) consists of Ethernet, console, and auxiliary connectors for the Routing Engines and alarm relay contacts (see Figure 14). The front electrostatic discharge point is located near the bottom of the CIP. The CIP is located at the left side of the FPC card cage.

The CIP is hot-pluggable.

Figure 14: CIP



Routing Engine Ports

The CIP has two sets of ports you use to connect the Routing Engines to external management devices (see Figure 15). From these management devices, you can use the CLI to configure the routing node.

The upper set of ports, labeled HOST0, connects to the Routing Engine in slot RE0, and the lower set, labeled HOST1, connects to the Routing Engine in slot RE1. Each set includes the following ports:

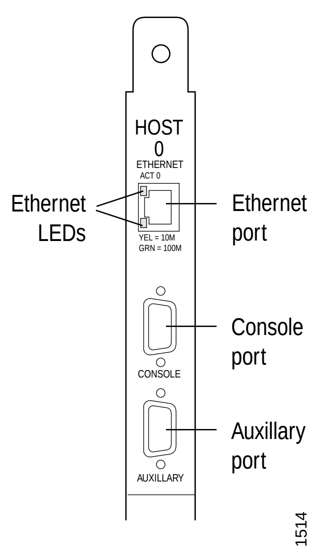
ETHERNET management port—Used to connect the Routing Engine to a management LAN (or any other device that plugs into an Ethernet connection) for out-of-band management of the routing node. The Ethernet port can be 10 or 100 Mbps and uses an autosensing RJ-45 connector.

The Ethernet management port has two LEDs, which indicate the type of connection in use. A yellow LED lights when a 10-Mbps connection is active, and a green LED lights when a 100-Mbps connection is active.

CONSOLE port—Used to connect a system console to the Routing Engine with an RS-232 serial cable.

AUXILIARY port—Used to connect a laptop computer or modem to the Routing Engine with an RS-232 cable.

Figure 15: Routing Engine Ports on CIP



Alarm Relay Contacts

The CIP has two sets of alarm relay contacts for connecting the routing node to external alarm devices (see Figure 14 on page 26). Whenever a system condition triggers either the red or yellow alarm on the craft interface, the alarm relay contacts are also activated. The alarm relay contacts are located below the Routing Engine ports.

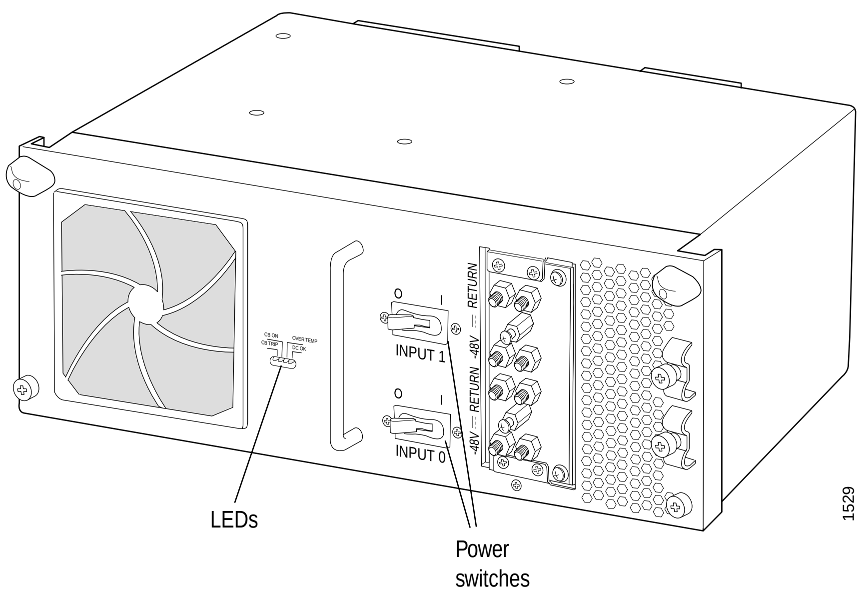
Power Supplies

The routing node has two load-sharing DC power supplies (see Figure 16), located at the lower rear of the chassis. The power supplies connect to the midplane, which distributes the different output voltages produced by the power supplies to the routing node components, depending on their voltage requirements. Each power supply has two inputs, each with its own 80 A circuit breaker and each requiring a dedicated DC power source.

The power supplies are fully redundant. If one power supply fails or is removed, the second power supply instantly assumes the entire electrical load. A single power supply can provide full power (up to 6500 W) for as long as the routing node is operational. Redundancy is necessary only in case of power supply failure.

Power supplies are hot-removable and hot-insertable. The routing node supports DC power only. Each power supply is cooled by its own internal cooling system.

Figure 16: Power Supply



Power Supply Electrical Specifications

Table 9 lists the power supply electrical specifications.

Table 9: Power Supply Electrical Specifications

Item	Specification
Maximum input power	6500 W
DC input voltage	Nominal –48 VDC, –60 VDC Operating range: –42 to –72 VDC
Input DC current rating	68 A @ –48 VDC (nominal) for each input 152 A @ –48 VDC (nominal) system current rating

Power Supply LEDs

Four LEDs on each power supply faceplate indicate the status of the power supply. In addition, a power supply failure triggers the red alarm LED on the craft interface. Table 10 describes the functions of the power supply LEDs.

Table 10: Power Supply LEDs

LED	Color	State	Description
CB ON	Green	On steadily	Power supply is installed correctly and is functioning normally, is receiving power, and circuit breaker is on.
CB TRIP	Amber	On steadily	Circuit breaker not turned on, or host subsystem has detected a failure and has turned circuit breaker off.
OVER TEMP	Amber	On steadily	Power supply has exceeded recommended temperature.
DC OK	Blue	On steadily	Power supply is installed correctly and is functioning normally.
		Blinking	Power supply is starting up, is not functioning, or is not properly installed.

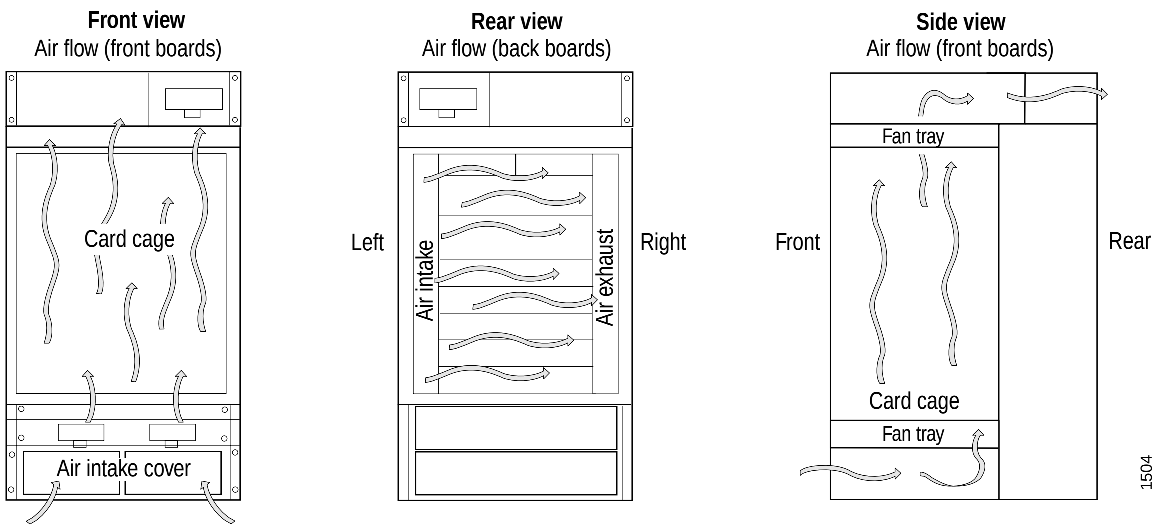
Cooling System

The cooling system consists of the following components:

- Two front fan trays
- Front air filter
- Rear fan tray
- Rear air filter

The cooling system components work together to keep all routing node components within the acceptable temperature range (see Figure 17). All fan trays and filters are hot-insertable and hot-removable. The two front fan trays are interchangeable. The front and rear fan trays are not interchangeable.

Figure 17: Air Flow through the Chassis



The host subsystem monitors the temperature of the routing node components. When the routing node is operating normally, the fans function at lower than full speed. If a fan fails, the speed of the remaining fans is automatically adjusted to keep the temperature within the acceptable range.

Cable Management System

The cable management system (see Figure 18) consists of a row of nine semicircular plastic bobbins mounted on the front of the routing node below the FPC card cage. The PIC cables wrap around the bobbins, keeping the cables organized and securely in place. The curvature of the bobbins also helps maintain the proper bend radius for optical PIC cables.

Figure 18: Cable Management System